Public Abstract

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Nanotechnology is now applied in various industries, including electrical engineering, chemistry, material sciences and cosmetics (Kumar 2006). There is potential power of applications of nanotechnology in the many aspects of food industry such as food safety, disease treatment delivery methods, new tools for molecular and cellular biology, new materials for pathogen detection and protection of the environment (Weiss, Takhistov, and Clements 2006). ZnO NPs and Ag NPs have a significant potential for a wide range of biological applications, including as an antifungal and antibacterial agent for antibiotic resistant organisms and for preventing infections.

Recent studies have demonstrated the antimicrobial activities of ZnO and Ag NPs to pathogenic microorganisms, including Escherichia coli O157:H7, Staphylococcus aureus, Streptococcus pyogenes, Listeria monocytogenes, Salmonella Enteritidis, Salmonella Typhimurium Bacillus cereus, Campylobacter jejuni, Botrytis cinerea, and Penicillium expansum. However, not much is known about the behavior of ZnO and Ag NPs upon ingestion and whether they inhibit natural gut microflora.

In this study, we investigated the effect of ZnO and Ag NPs on three important intestinal bacteria, E. coli, L. acidophilus, and B. animalis. The modes of action of ZnO and Ag NPs on the growth of the bacterial cells were also studied by a combination of chemical analytical methods.

The presence and characterization of ZnO and Ag NPs on bacterial cells were investigated by scanning electron microscopy (SEM), transmission electron microscopy (TEM), and energy-dispersive X-ray spectroscopy (EDS). UV-visible absorbance and the Live/Dead Bacterial Viability assay were performed to assess membrane leakage and viability of bacterial cells before and after treatment with the NPs.

In summary, ZnO and Ag NPs exhibited mild antibacterial effects against intestinal bacteria, E. coli, L. acidophilus, and B. animalis. Inhibitory effects slightly increased as the concentrations of NPs increased. Results showed that bacterial strains exposed to ZnO NPs for 10 h and Ag NPs for 6 h suffered the most antimicrobial effect. However, the numbers of treated cells were within 1 log CFU/mL less than that of the control and the reduction percentage in the number of cells were about 10% or less. The results of SEM and TEM images and EDS demonstrated the morphological changes of the cells and the adherence of NPs to bacterial cells. Some externally and internally damaged cells were observed. However, not all cells were damaged, and there were still many cells in normal size with intact intracellular structures and well-organized intracellular contents which correlated with the results of numbers of cells reduction. Also, results of the UV absorbance and cell viability assay correlated with the previous experiment results. The results of the UV absorbance indicated that no significant amounts of internal cellular contents were leaked due to NPs. Finally, the viability assay of bacterial cells confirmed that more live than dead cells were present after treatment with NPs. Overall results indicate that not all cells were affected by NPs.

According to all results obtained in this study, ZnO and Ag NPs have very mild inhibitory effects on intestinal bacteria as compared to those of pathogenic microorganisms that have been done in previous studies. The contamination level of ZnO and Ag NPs in food sample, if present, is very low, and in this study, a much higher concentration of NPs were tested. The data obtained from this study indicate that the food contaminated with ZnO and Ag NPs offers a negligible threat to the beneficial gut microflora.